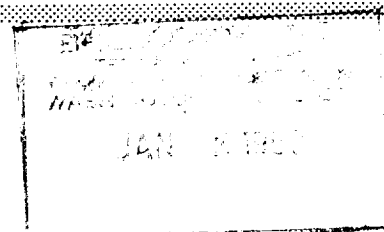


~~SS. FINEBLUM.~~

NHB 5300.5  
MAY 1967  
EDITION

OFFICE OF  
MANNED SPACE FLIGHT

APOLLO APPLICATIONS PROGRAM



APOLLO APPLICATIONS  
RELIABILITY  
AND  
QUALITY ASSURANCE  
PROGRAM PLAN

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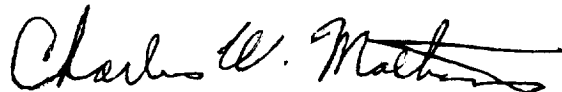
PREFACE

May 1, 1967

This document is an official release of the Apollo Applications Program Office and has been prepared in accordance with the requirements of the Apollo Applications Program Development Plan.

This plan is based on NASA Publications NPC 250-1, NPC 200-1A, NPC 200-2 and NPC 200-3. The basic tasks described in these and the other referenced documents listed in Appendix A - Category A and B form a part of this plan where applicable but are not repeated within it, other than by reference. Instead, significant tasks which are either modified or expanded from the above publications, or are not included in these publications, are described herein. The combined documents, therefore, constitute the Apollo Applications Reliability and Quality Assurance Policy. As in the above listed publications, Center Reliability and Quality Assurance offices will select from this plan the applicable tasks and place them in individual procurement contracts and statements of work.

The Center Program Offices should compare the benefits to be derived with the problems of implementation, and coordinate any major deviations with the Reliability and Quality Assurance Director, Apollo Applications Program Office.



Charles W. Mathews, Director  
Apollo Applications Program

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# APOLLO APPLICATIONS RELIABILITY AND QUALITY ASSURANCE PROGRAM PLAN

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## SECTION 1: INTRODUCTION

### 1.1 PURPOSE

The purpose of this document is to set forth the requirements for implementing and evaluating the Apollo Applications Reliability and Quality Assurance Program.

### 1.2 SCOPE

- a. The organizational elements participating in the Apollo Applications Program will implement the provisions of this publication. Timely coordination with the Apollo Applications Reliability and Quality Assurance Program Director will be accomplished as any deviations are considered necessary.
- b. This publication is applicable to all Apollo Applications hardware elements, including but not limited to the following:
  - (1) Apollo Basic Hardware
  - (2) Apollo Modified Hardware
  - (3) Apollo Applications Peculiar Hardware
  - (4) Experiments
  - (5) Vehicle and Launch System Mission Essential Ground Support Equipment (GSE) and Ground Operations Support Systems (GOSS).
  - (6) Crew System Equipment

### 1.3 AUTHORITY

- a. The series of NASA Projects Approval Documents (PAD) establishes approval of the Apollo Applications Program.
- b. The Apollo Applications Program Development Plan (PDP), presents the broad policies for the Apollo Applications Reliability and Quality Assurance Program and identifies the requirement for an Apollo Applications Reliability and Quality Assurance Plan.

### 1.4 APPLICABLE DOCUMENTS

Documents applicable to the Apollo Applications Reliability and Quality Assurance Program are listed in Appendix A and are correlated to specific requirements in Appendix B.

### 1.5 GLOSSARY OF TERMS

Appendix C contains a glossary of terms used in this publication.



## SECTION 2: RELIABILITY AND QUALITY ASSURANCE REQUIREMENTS

### 2.1 GENERAL

The Apollo Applications Reliability and Quality Assurance Program is a series of required activities which take place during the various hardware program phases, all directed toward meeting the Apollo Applications performance requirements established in the Apollo Applications Program Specification. This section identifies Reliability and Quality Assurance requirements. In those cases where available documentation inadequately covers the subject as applicable to the Apollo Applications Program, more specific definition of the requirements is included in this section. The implementation of requirements is referenced to program milestones and described in Section 3.

### 2.2 RELIABILITY AND QUALITY ASSURANCE PLANS

#### 2.2.1 General

Requirements and procedures for implementation of the Apollo Applications Reliability and Quality Assurance Program will be developed in plans prepared by Contractors and Delegated Government Agencies who have inspection cognizance within the contractors' plants. Existing documents may be referenced and submitted as part of the Reliability and Quality Assurance plans forwarded to Center Apollo Applications Program Offices for approval.

#### 2.2.2 Contractor Reliability and Quality Assurance Plans

##### 2.2.2.1 Requirement Categories

Each Contractor Reliability and Quality Assurance Office is responsible for the development of Reliability and Quality Assurance plans containing requirements in the following basic categories to the extent applicable for the hardware developed under their cognizance:

- a) Requirements maintained for Apollo hardware which is assigned to the Apollo Applications Program.
- b) Requirements for Modified Apollo hardware which rely on on-going Apollo Reliability and Quality Assurance activities. (Reference NHB 5300.1A, Apollo Reliability and Quality Assurance Plan)
- c) Requirements established specifically for Apollo Applications Peculiar Hardware and Experiments.

- d) Requirements established for vehicle and launch system missions essential Ground Support Equipment (GSE) and Ground Operational Support System (GOSS).
- e) Requirements established for Crew System Equipment.

#### 2.2.2.2 Specific Reliability and Quality Assurance Provisions in Contractors' Reliability and Quality Assurance Plans

The Contractors' Apollo Applications Program Reliability and Quality Assurance Plans will include but not be limited to the following:

- a) A brief description of organizational structure, functional responsibilities and functional interrelationships.
- b) Plans for reviewing and approving major procurement documents with respect to Reliability and Quality Assurance requirements.
- c) Plans for self audit of Reliability and Quality Assurance activities.
- d) Plans for placing acceptance and qualification requirements in contractual documents and specifications.
- e) Plans for Reliability and Quality Assurance review of test plans for Reliability and Quality Assurance requirements, plans for monitoring test performance, and plans for evaluation of test results against acceptance and qualification requirements in specifications.
- f) Plans for performance of training, motivation, and maintenance of proficiency.
- g) Requirements for failure reporting, failure analysis, and corrective action (see paragraphs 2.6 and 2.7).
- h) Plans for assessing hardware and documentation status at the following six key checkpoints:
  - (1) PDR - Preliminary Design Review
  - (2) CDR - Critical Design Review
  - (3) CI - Configuration Inspection
  - (4) COFW - Certification of Flight Worthiness (Acceptance Review)
  - (5) DCR - Design Certification Review
  - (6) FRR - Flight Readiness Review
- i) Plans for reviewing design specifications and for implementation of specification review actions (see paragraph 2.4).

- j. Plans for performing Failure Mode, Effect and Criticality Analyses (see paragraph 2.8).
- k. Plans for reporting of significant trends including manpower.

#### 2.2.2.3 Contractor Reliability and Quality Assurance Plan Format

The recommended plan format is a listing of specific Reliability and Quality Assurance Tasks which are concisely described, with organizational responsibility assigned, and scheduled so that they can be effectively monitored.

### 2.3 SPECIAL CONSIDERATIONS

#### 2.3.1 Experiments

All experiment equipment must be designed, manufactured, and tested to standards which do not degrade flight safety and which enhance the success of accomplishing the experiment. Emphasis will be given to:

- a. Selection of materials in Crew Bay Area (see paragraph 2.12.1). Non-metallic materials will be selected from the acceptable materials listed in MSC-A-D-66-4. Materials which are not in the report will be submitted to the PIC, who will review and approve the request for usage.
- b. Elements of the test program related to critical components (see paragraph 2.9). Crew safety analysis or demonstration by test will be accomplished for each component part. The results will be submitted to the Payload Integration Center (PIC) as part of the acceptance documentation package.
- c. Environmental Acceptance Testing (see paragraph 2.5.2).
- d. Requiring the Payload Integration Center to provide the experimenter and Experiment Development Center with a full environmental envelope for the experiment equipment. Experiment design, parts and process selection, and packaging of the experiment must be compatible with expected flight environments.
- e. Selection of parts per paragraph 2.12 and 2.13. Selected parts which are not listed in the Data Banks will be proposed to the Payload Integration Center, who will review and approve the request for usage.

- f. Conducting design reviews of the experiment prior to acceptance of the flight hardware at a time scheduled by the Payload Integration Center . The review will include and emphasize such areas as:
- (1) Selection of parts and materials
  - (2) Design margins
  - (3) Acceptance test requirements
  - (4) Crew safety analysis
  - (5) Test history and failure history to date
  - (6) Experiment packaging

### 2.3.2 Ground Support Equipment

The requirements and procedures set forth in the various sections of this document apply to all AAP hardware elements including Ground Support Equipment (GSE). It is recognized , however, that GSE differs from flight hardware in several aspects including:

- 1) Weight or volumetric limitations not critical.
- 2) Continued usage of GSE over a period of years with many duty cycles.
- 3) Ease of maintenance and availability of spares.
- 4) The preponderance of GSE is already built and in place with only limited modifications and/or additions required for AAP usage. AAP GSE R&QA activities shall receive special emphasis, as appropriate (based on GSE functions) in the following areas:
  - a) Re-assessment of existing reliability analyses, FMEA's, qualification test histories, operational data (such as time and cycle life of components), test and checkout procedures, human error potential evaluations, hardware maintenance procedures and operational instructions.
  - b) Comparing the above re-assessment to AAP pre-launch requirements including the consideration of the AAP multiple launches.
  - c) Identification of hazardous pre-launch operations and correlation with existing control instructions/procedures (including contingency procedures).
  - d) Insuring the developing of new control instructions/procedures where existing ones are inadequate.
  - e) Monitoring of program activities for compliance with control instructions.
  - f) Elimination of single failure points.

## 2.4 DESIGN SPECIFICATION REVIEW

### 2.4.1 General

Each Apollo Applications Program Center and Contractor Reliability and Quality Assurance Office is responsible for assuring the review of design specifications under their cognizance. The review will cover items of flight and ground support hardware. Each specification will be reviewed for performance requirements, environmental requirements, pertinent test criteria, safety margins, derating factors, maintainability and elimination of human induced failures, qualification and acceptance requirements and apportioned reliability goals (including definition of satisfactory performance). The appropriate mission profile will be used in the review of each specification in order to accomplish an adequate correlation between mission requirements and design specifications.

### 2.4.2 Environmental Requirements

Each specification will be reviewed for overall environmental requirements. The specification will be reviewed against the requirements of the mission profile environments and ground operations environments.

### 2.4.3 Test Criteria

Each specification will be reviewed to insure that Reliability and Quality Assurance requirements are fully reflected in criteria for development, qualification, acceptance tests, and data requirements.

### 2.4.4 Design/Safety Margins

Each specification will be reviewed for safety margins which have been applied to combinations of environment and operating load. The review will be updated for each mission profile, environment, configuration or weight reduction change for presentation at Design Certification Reviews.

### 2.4.5 Reliability Goals

Center Project Managers will take all practical steps in the design of flight and ground hardware, the planning of flight and ground tests, the formulation of mission profiles and mission rules, and the training of the crew and operations personnel to insure mission success and crew safety. Each Center Apollo Applications Project



Office is responsible for establishing clearly stated reliability goals for Apollo Applications Program hardware developed under their cognizance, and for defining the conditions which will constitute achievement of these goals. These goals will include the following elements, as appropriate:

- 1) The identification of failure modes, for various modes of operation - the categorization of failure modes by criticality the establishment of explicit test and/or analysis requirements pertaining to Category 1 and 2 failure modes -- the establishment of contingency procedures for all Category 1 and 2 failure modes.
- 2) No single failure will cause the loss of any crew member, prevent the continuation of the mission, or prevent a successful early termination of the mission.
- 3) Prior flight and/or ground tests will have demonstrated that system elements are capable of meeting the mission requirements (including any special requirements associated with early termination). For those system elements which will not have been fully verified by prior flight and/or ground tests, engineering analyses will substantiate their capability of meeting mission requirements.
- 4) Failed parts analyses and corrective action, as appropriate, will have been accomplished for all failures experienced during the testing programs.
- 5) The establishment of design margins/safety margins for all mission critical parameters.
- 6) The establishment of quantitative design reliability goals.

#### 2.4.6 Flight Hardware/Experiment Interface

Each specification will be reviewed for definition of hardware/experiment interfaces, to determine functional compatibility and to identify any compromise of structural integrity. This interface definition will be documented in the design specification by the Payload Integration Center. The review will include such factors as payload volumes and weights, integrated test, crew safety, test acceptance and checkout requirements, interface requirements and environmental criteria.

#### 2.4.7 Limited Life Items

Each specification will be reviewed for inclusion of Limited Life Item identification and control. The specification must indicate specific replacement level items, their useful life, and specifications for recording operating time which has accrued.

### 2.5.1 General

Test results and other data resulting from implementation of the Apollo Applications Test Program are vital to the Reliability and Quality Assurance function. Effective utilization of these results requires that each Center and Contractor Reliability and Quality Assurance Office maintains a close working relationship with the test activity. Emphasis should be given to supporting and monitoring the following test activities. Additional Center and Contractor test activities and Reliability and Quality Assurance test interface responsibilities are contained in the Apollo Applications Program Test Requirements document.

### 2.5.2 Environmental Acceptance Testing (EAT)

Reliability and Quality Assurance will review test criteria and requirements for assurance that environmental testing will be utilized to uncover defects which are not visible or apparent with normal inspection techniques. Applicable production and qualification test components will be subject to such environmental testing prior to operational usage or qualification testing. These test components will be selected considering the articles' susceptibility to manufacturing problems for assurance that assembly operations and manufacturing processes (i.e., soldering, welding, brazing, bonding, etc.) do not affect the articles' designed performance. The test environments should be of sufficient severity to uncover the defects but not severe enough to cause any damage to the component.

### 2.5.3 Failure Mode, Effect and Criticality Analysis (FMECA)

Reliability and Quality Assurance will furnish the results of Failure Mode, Effect and Criticality Analyses and Single Failure Points on Apollo Applications Program Hardware to Apollo Applications test personnel at Centers and contractors' facilities for consideration in test planning, establishment of checkout procedures, required frequency of monitoring during checkout, and overall test emphasis. (See paragraph 2.8). The results of these analyses must be supplied to the proper organizations for appropriate action.

### 2.5.4 Reliability Tests

Data necessary for the Apollo Applications Program reliability analysis will be acquired from prior programs (particularly Apollo) and from Apollo Applications Program qualification tests. Similarly, program managers will establish test requirements for qualification of critical components which will include "over-stress testing" and "test to failure" as appropriate. The designation of hardware as being in the "critical component category" will result from the systematic

review of Failure Mode, Effect and Criticality Analyses, Single Failure Point Summaries, Testing History, and Test Verification Status.

#### 2.5.5 Resolution of Test Failures

##### a) Control of Initial Failure Investigation

Reliability and Quality Assurance will assure that failure analyses are performed on test malfunctions. A test should be immediately stopped when a malfunction occurs and isolation analyses accomplished before any hardware is removed, altered or the test started again. Additional tests which are part of the failure analysis should not be precluded. The failure analysis should determine if the malfunction resulted from operator error, test equipment malfunction, procedural error, or malfunction of external inputs to the system. Results of the analysis will be documented for review and close-out action.

##### b) Transient Malfunction Control

Reliability and Quality Assurance will review test documents to see that they provide for permanent disqualification of the malfunctioning flight equipment end item if failure analysis has been unable to determine the cause of failure.

#### 2.5.6 Data Trend Monitoring

Reliability and Quality Assurance will review the test plan for procedures established to monitor test results and detect impending out-of-tolerance performance or failure. Reliability and Quality Assurance will provide Test with criteria (Failure Mode, Effect and Criticality Analyses, Logic Diagrams, Reliability Estimates, Single Failure Points) which can serve as the basis for determining those key performance parameters which, in turn, will determine the test points to be specifically monitored. When the monitoring activity and resulting trend analyses indicate impending trouble, reviews will be performed and necessary actions determined. Reliability and Quality Assurance will support these reviews.

#### 2.5.7 Operating Cycle/Time

Reliability and Quality Assurance will review test procedures for inclusion of instructions for recording the operating cycle/time of limited life components. These procedures should cover the disposition of limited life components whose cumulative operating time or cycle has reached the maximum allowable or whose anticipated cumulative operating time or cycles will reach the limit during succeeding checkout

and mission operations. Also required is a time/cycle monitoring system for measuring operating time/cycles for flight system equipments. (For example, the recording of ON time for primary power buses.)

## 2.6 FAILURE AND DEFECT REPORTING, ANALYSIS, AND CONTROL

### 2.6.1 General

Apollo Applications Program Reliability and Quality Assurance Offices are responsible for assuring that Centers and contractors employ a controlled system for reporting, analyzing, correcting, verifying and feeding back data on all failures and discrepancies. No failure will be considered random for the purpose of performing a failure analysis and every failure will be considered to have a detectable cause. Any failure occurring during unit level acceptance and subsequent testing will be reported. The program will be based on the premise that no mission will be flown with open failed parts analysis charged against it without proper risk evaluation or a full understanding of the failure mechanism.

### 2.6.2 Systems Capabilities

The Failure Reporting System will have the following characteristics:

- a) All failures and defects will be considered open until corrective action has been defined and implemented.
- b) Reporting of open failures and overall status will be scheduled to provide program management with timely knowledge of risk.
- c) Regardless of the degree of automation of the system, raw data will be maintained to assist in detailed analysis.
- d) Data within the system must be accessible to the extent necessary to permit detailed review and analysis by Reliability and Quality Assurance personnel from the next higher level of organization.
- e) Each report of failure on limited life items will include elapsed operating time/cycles at point of failure.
- f) Failure information on similar hardware from other programs and sources will be sought out and included, if applicable, as part of the failure analysis/corrective action system.

## 2.7 FLIGHT ANOMALIES REPORTING (FLARE) SYSTEM

The following information will be provided to the Apollo Applications Program Reliability and Quality Assurance Office to support the preparation of the Flight Anomalies Report:

- a) All identified flight anomalies and pre-launch mission failures associated with flight hardware, ground operational support equipment, and the launch complex.
- b) The assignment of a criticality category to each anomaly (Category 1, 2, 3a, and 3b) and the possible effect of the anomaly on future missions.
- c) Identified mode of failure and cause of each anomaly and the status of all planned corrective actions, and effect of corrective action on future missions.
- d) The relationship of anomalies/failures to significant items reported in the Flight Readiness Reviews and other program sources.
- e) The correlation between anomalies/failure and previous Failure Mode, Effect and Criticality Analyses; trends and other related Reliability and Quality analyses.

## 2.8 FAILURE MODE, EFFECT AND CRITICALITY ANALYSIS (FMECA)

Each Apollo Applications Center and Contractor Reliability and Quality Assurance Office is responsible for assuring the development of a Failure Mode, Effect and Criticality Analysis System to determine possible modes of failure and criticality of the associated effect. This analysis is required for the correlation of possible failure modes, experienced failure modes, and the effect on mission success and crew safety.

## 2.9 SINGLE FAILURE POINTS

### 2.9.1 General

Each Apollo Applications Program Center and Contractor Reliability Assurance Office is responsible for assuring reporting and controlling of Single Failure Points.

For each mission, a Single Failure Point Summary of items listed within criticality (priority) categories 1 and 2 will be prepared, updated, and submitted to the Program Director. Supporting information will be included which delineates:

- a) Single Failure Point mode.
- b) Corrective action and effective date.
- c) Justification of retaining a Single Failure Point when corrective action is not implemented.
- d) Mission and Crew safety consequences of retaining each Single Failure Point.

## 2.10 MISSION RELIABILITY ANALYSIS

### 2.10.1 General

Each Apollo Applications Program Center and Contractor Reliability and Quality Assurance Office will be responsible for assuring the performance of reliability analyses. The purpose of these analyses is to identify critical hardware and functions within the program and to initiate corrective action which will enhance mission success and crew safety. This will be accomplished primarily by assessing the interaction of equipment design, equipment utilization, mission events, mission environments, and mission operations. The analyses developed for the Apollo Program will be extended and modified as required. Maximum utilization of available data is required. Analyses for Apollo Applications peculiar hardware and experiments should be developed utilizing Apollo experience as a baseline (Ref. NHB 5300.1A). The extent of both qualitative and quantitative analysis to be accomplished will be governed by the relative opportunity for increasing the probability of mission success and crew safety.

### 2.10.2 Headquarters Apollo Applications Program Office Reliability Analysis

Program office reliability analysis will be concerned with the program level aspects of mission reliability, including crew safety and launch availability. The analysis considers the interfaces between the spacecraft, launch vehicle, launch complex, and ground operations support systems; the interactions between pre-launch and post launch phases of the mission; all mission and abort modes; and the interaction between reliability procedures, costs, and schedules.

### 2.10.3 Apollo Applications Center Reliability Analysis

Center reliability analysis will be concerned with evaluating the interactions of the hardware within the scope of the Center's responsibility and, in general, will be governed by the Center's role relative to hardware development, payload integration, and mission control.

### 2.10.4 Apollo Applications Contractor Reliability Analysis

Each Apollo Applications Contractor will perform reliability analysis as required by the cognizant Center.

## 2.11 INFLIGHT MAINTENANCE

### 2.11.1 General

Each Center Reliability and Quality Assurance Office is responsible for assuring the development of an inflight maintenance plan for the hardware being developed under its cognizance. Each Center's plan will be based on its evaluation of the capability of performing inflight maintenance during Apollo Applications Missions. Establishment of this capability is intended to provide a means for extending the mission operations and the experiment performance where possible, to mission completion following the detection of a defect/failure.

### 2.11.2 Analysis and Plan Development

Each Center is responsible for assuring that the reliability analysis conducted under its cognizance is utilized in the practical implementation of inflight maintenance. Implementation of inflight maintenance provisions will vary from Center to Center based on all aspects of maintainability for the hardware being developed under their cognizance. The Headquarters Apollo Applications Program Office (Reliability and Quality Assurance) will integrate the results of the Center analyses into an overall inflight maintenance plan which will give due consideration to the following requirement - Apollo Applications Missions will have mission periods beyond the Apollo System Design limits by utilizing logistic systems support and resupply flights.

## 2.12 PARTS, MATERIALS AND COMPONENTS PROGRAM

### 2.12.1 Selection

The Apollo Applications Program policy is to select parts previously proven reliable in other missile and space programs (see paragraph 2.13). These parts will be tested, as necessary, to determine that they are satisfactory for use in the Apollo Applications Program.

Additional selection considerations are as follows:

- a) The selection of materials for use in crew bay environments (Including S-IVB Orbital Workshop, Airlock Module, Command Module, Lunar Module, Multiple Docking Adapter) and associ-

ated experiments will meet the requirements of the following Manned Spacecraft Center documents:

- (1) Procedures and Requirements for the Evaluation of Apollo Crew Bay Materials, MSC-A-D-66-3.
  - (2) Crew Bay Non-Metallic Materials Status Report, MSC-A-D-66-4.
- b) The selection of any material must consider the compatibility with liquids or gases, as well as other environments to which it will be exposed.

#### 2.12.2 Control

All elements of the Apollo Applications Program will establish specific controls on parts, materials, and components during procurement, manufacture, inspection, test, and end use.

Specific control considerations are as follows:

- a) The Apollo Applications Program Reliability and Quality Assurance Office will monitor and review parts programs at the Centers; and the Centers will monitor their in-house programs and their contractors' programs to determine adequacy of existing procedures and compliance with these procedures. Recommendations will be made for program improvement.
- b) Apollo Applications Program Centers will maintain parts and materials data and implement programs for timely interchange of these data as required.
- c) A contamination control program will be utilized to enhance the reliability and quality of parts, materials, and components. This program will use NHB 5300.3 dated August, 1966, and the MSC Contamination Control Handbook as a guide and will emphasize:
  - (1) Design consideration of standards for contamination control.
  - (2) Achievement, verification, and maintenance of the required level of cleanliness.
  - (3) A means to indicate violation of cleanliness requirements.

- d) Procedures will be established assuring parts traceability by part number, manufacturer, serial number, date, or lot code, as appropriate, and location as used in Apollo Applications Program hardware. (See Apollo Applications Program Directive \_\_\_\_\_.)
- e) All parts, materials, and components determined to be defective or nonconforming will be controlled as outlined in Apollo Applications Program Directive \_\_\_\_\_.
- f) Procedures will be established for maintaining material/gas/liquid compatibility records.

## 2.13 PARTS AND MATERIALS DATA BANK

The existing Apollo parts information programs consisting of Manned Spacecraft Center and Marshall Space Flight Center Data Bank (APIC) will be used by Apollo Applications Program participants for collection, storage and dissemination of parts and materials information in accordance with Instruction MA 1450.045.

## 2.14 AUDITING

- a) Audits will be performed by both NASA installations and Apollo Applications Program Office Reliability and Quality Assurance personnel at periodic intervals to evaluate compliance with established Apollo Applications Program Reliability and Quality Assurance requirements.
- b) Summary reports of all audits will be published for information purposes and as a basis for corrective action and follow-up.

## 2.15 STATUS REPORTING

Apollo Applications Program Reliability and Quality Assurance Status Reports will be exchanged informally between the Centers and the Apollo Applications Program Office. The status report will include such items as:

- a) Significant Reliability and Quality Assurance problem areas
- b) Plans for corrective action
- c) Status of major key elements
- d) Plans for next reporting period
- e) Significant trends affecting reliability or quality assurance (to be developed).



## SECTION 3: IMPLEMENTATION

### 3.1 GENERAL

The purpose of this section is to indicate how the requirements which have been presented are integrated into the Apollo Applications Program. This is accomplished by relating the outputs of these requirements to the key program milestones (checkpoints).

### 3.2 SCHEDULES/MILESTONES

This section delineates the key Apollo Applications Program milestones for a typical Apollo Applications Program mission. Requirements are specified for each key program milestone in section 3.3. The documentation and supporting data will be scheduled in Contractor Milestone Review Plans. (See Figure 1 chart on page 3.7). Center Reliability and Quality Assurance personnel should use this listing, as applicable, as a checklist to determine status of readiness for the Milestone Review.

### 3.3 MILESTONES

Requirements for each of the key program milestones are incorporated in the following listing. Each Reliability and Quality Assurance requirement is referenced to an appropriate section of this plan or to appropriate documentation outlined in Appendix B.

#### 3.3.1 Milestones and - Experiment Development/Implementation Plan; Experiment Approval.

- Reliability and Quality Assurance Program Plan (See paragraph 2.2).

#### 3.3.2 Milestones and - Preliminary Design Review (PDR).

- Summary of design and performance requirements (should be available from Program Definition Phase).
- \* ◦ Compatibility evaluation of selected design approach with design and performance requirements.
- \* ◦ Compatibility evaluation of Contract End Item (i.e., stage/module/subsystem) with other system equipment/facilities.

- o Summary of formal verification requirements and method of verification for each performance and design requirement (should be available from Program Definition Phase).
  - o Summary of reliability and safety requirements (in quantitative or qualitative terms, as appropriate) and definition of conditions which will constitute achievement of these requirements (should be available from Program Definition Phase). (See paragraph 2.2.2).
  - o Preliminary Failure Mode, Effect and Criticality Analysis and summary of associated test and/or analysis requirements for Category 1 and 2 failures (presumes the existence of a Design Reference Mission or equivalent). (See paragraph 2.8).
- \*
  - o Summary of design trade-off studies - conclusions/recommendations and reliability considerations for each. (See paragraph 2.10.1).
  - o Preliminary maintainability analysis (in-flight and pre-launch) (See paragraph 2.11.2).
- \* Generated by contractor design/engineering groups with participation by reliability.

### 3.3.3 Milestones and - Critical Design Review (CDR).

- o Updated summary of design and performance requirements.
- o Updated compatibility evaluation of stage/module/subsystem, as designed with previously established performance and design requirements.
- o Updated compatibility evaluation of completed design with the rest of the system (particularly with approved Interface Control Documents).
- o Evaluate test specifications for adequacy and compliance with previously established verification requirements. (See paragraph 2.5.1).
- o Qualification test plans/Qualification test status. (See paragraph 2.5.1).
- o System Functional Logic Block Diagrams. (See paragraph 2.10.2).

- o Updated Failure Mode, Effect and Criticality Analysis/single failure point listing/Preliminary contingency procedures for Category 1 and 2 failures. (See paragraph 2.8 and 2.9).
- o Reliability Prediction. (NPC 250-1).
- o Updated maintainability analysis - inflight and pre-launch. (See paragraph 2.11.2).
- o Detailed Inspection Plans. (NPC 200-1A, 200-2, 200-3).
- o Design/Manufacturing Compatibility (producibility) Analysis. (See paragraph 2.4.1).
- o Updated summary of design trade-off studies - conclusions/recommendations and reliability considerations for each. (See paragraph 2.10.1).
- o Safety Plans. (See paragraph 2.4.4).
- o Open Failures Identification and Status. (See paragraphs 2.6 and 2.15).
- o Survey and Audit results. (See paragraph 2.14).

#### 3.3.4 Milestones and - Assigned to Apollo Applications Program.

Note: Requirements necessary for the design milestones must be completed and supporting documentation available when Apollo hardware is assigned to Apollo Applications Program.  
(See milestones 3, 4, 5, and 6).

#### 3.3.5 Milestones , , and - Configuration Inspection (CI).

- o Summary of differences between End Item "Qualified" and End Item "CI" and evaluation including reliability effects.
- o Updated Failure Mode, Effect and Criticality Analysis (FMECA). (See paragraph 2.8).
- o Survey and audit results. (See paragraph 2.14).
- o Qualification, reliability, and acceptance test results. (NPC 250-1, 200-2, and 200-3).

- o Establish validity of acceptance testing by direct comparison of test method and test data with design/performance requirements for End Item. (NPC 200-2).
- o Open failure identification and status. (See paragraph 2.6 and 2.15).
- o Failure and corrective action summary. (See paragraph 2.6).
- o Status of waivers and deviations including supporting data.

3.3.6 Milestones ~~13~~ , ~~14~~ , ~~15~~ , and ~~16~~ - Certification of Flight Worthiness (COFW)/Customer Acceptance Review.

- o Same as paragraph 3.3.5.

3.3.7 Milestone ~~17~~ - Design Certification Review (DCR).

Note: For those missions where a Design Certification Review is not scheduled, these inputs will be utilized for the Flight Readiness Review (Milestone 18).

- o Reliability Goal Status. (See paragraph 2.4.5).

Updated Failure Mode, Effect and Criticality Analysis (FMECA). (See paragraph 2.8).

Correlation summaries of Category 1 and 2 Failure Modes versus test and/or analysis results. (See paragraph 2.4.5).

Listing and evaluation of contingency procedures established for Category 1 and 2 failure modes. (See paragraph 2.4.5).

Single failure point listings for Category 1 and 2, justification for their existence, and test histories. (See paragraphs 2.4.5 and 2.9.1).

System verification status. (See paragraph 2.4.5).

Correlation summary of design margins/safety margins, versus mission critical parameters. (See paragraph 2.4.5).

Failure/corrective action summaries and status of open failures. (See paragraphs 2.4.5 and 2.6.2).

Comparison of assessed reliability versus design reliability goals. (See paragraph 2.4.5).

- o Summary of limited life items versus mission requirements. (See paragraph 2.4.7).
- o Qualification Test Status. (See paragraph 2.5.1).

### 3.3.8 Milestone - Flight Readiness Review (FRR).

- o Reliability Goal Status. (See paragraph 2.4.5).\*

Identification of single failure points (from FMECA's).  
(See paragraph 2.4.5).

Contingency procedures for Category 1 and 2 failure  
(from mission rules). (See paragraph 2.4.5).

System verification status. (See paragraph 2.4.5).

Updated failure/corrective action summary. (See paragraph 2.4.5).

Summary of design margins/safety margins for mission critical  
parameters. (See paragraph 2.4.5).

Comparison of assessed reliability versus design reliability  
goals. (See paragraph 2.4.5).

- o Results of hardware checkout and test operations up to the date of the Flight Readiness Review – including anomalies encountered, failure history and corrective action taken. (See paragraphs 2.5 and 2.6).
- o Summary of limited life items versus mission requirements. (See paragraph 2.4.7).
- o Open item status – Customer Acceptance Readiness Review/Certification of Flight Worthiness/Design Certification Review. (See paragraphs 2.6 and 2.15).

\* If Flight Readiness Review has been preceded by a DCR, updates only as required.

### 3.3.9 Milestone - Flight Anomaly Reporting (FLARE) System.

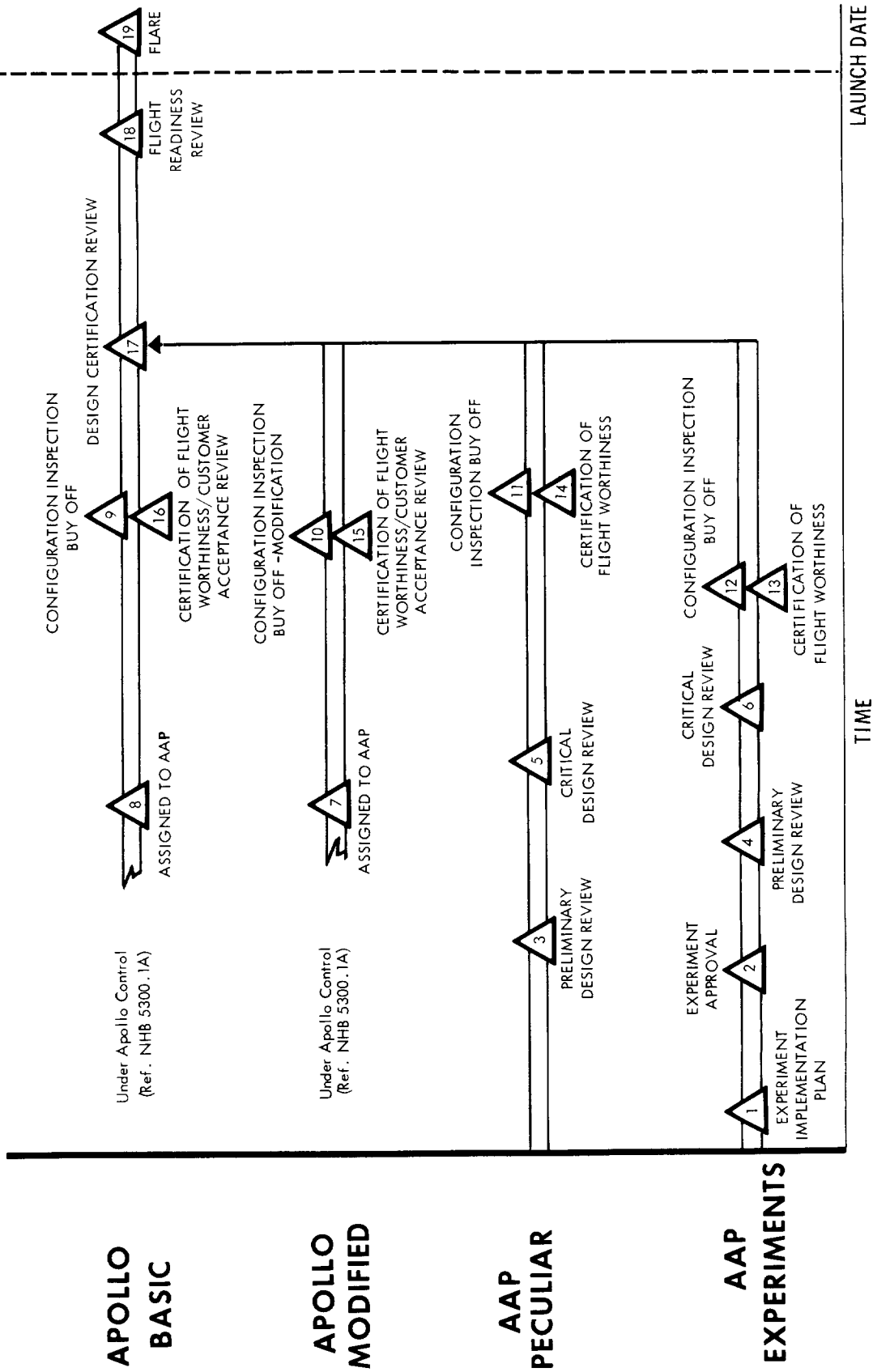
Note: Flight Anomaly items will be fed back into the on-going program.

- o Failure and Anomalies Listing Report. (See paragraph 2.7).



# AAP SCHEDULES / MILESTONES

FIGURE 1





## APPENDIX A

### REFERENCE DOCUMENTS

The following NASA documents are pertinent to this publication. Some may not be specifically referenced herein, but are listed, nevertheless, because they provide the basic authority for management of, or have technical impact on, the Apollo Application Program:

#### CATEGORY A - DIRECT REQUIREMENTS

NPC 200-1A,	Quality Assurance Provisions for Government Agencies, June 1964 Edition. <sup>2</sup>
NPC 200-2,	Quality Program Provisions for Space System Contractors, April 1962 Edition. <sup>2</sup>
NPC 200-3,	Inspection Provisions for Suppliers of Space Materials, Parts, Components and Services, April 1962 Edition. <sup>2</sup>
NPC 250-1,	Reliability Program Provisions for Space System Contractors, July 1963 Edition. <sup>2</sup>
_____	Experiment General Specification (AAP), (Under Preparation).
_____	Draft, Program Development Plan (AAP), June 20, 1966.
_____	Test Requirement Document (AAP), (Under Preparation).
_____	Test Plan Summary (AAP), (Under Preparation).
_____	Procedure for Human Error Control
_____	Mission Directives (AAP), (Under Preparation).
_____	Nonconforming Material Control, (Under Preparation).
_____	Identification for Traceability, (Under Preparation).
_____	Inflight Maintenance Plan.
_____	Critical Component Control Program for Vendor Motivation.
_____	AA Program Specification.
_____	In-Flight Maintenance Philosophy Directive.

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<sup>2</sup> Available from the Center Administrative Distribution Point for all NASA activities and from the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402 for all Contractors.

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### CATEGORY B - RELATED REQUIREMENTS

NMI 1052.12, NASA - Air Force Agreement relating to R&D Procurement and Field Service Functions, September 15, 1960.<sup>1</sup>

NMI 1052.15, NASA - Navy Agreement for Performance of Field Service Functions, March 1, 1962.<sup>1</sup>

NMI 1052.18, Department of the Army - NASA Agreement for Performance of Procurement Administration Functions, August 1, 1960.<sup>1</sup>

NMI 1052.38, DOD - NASA Agreement for Contract Administrative Services for NASA, Revised January 15, 1965.<sup>1</sup>

NMI 1710.1A, NASA Safety/Accident Prevention Program, July 11, 1966.<sup>1</sup>

NMI 1711.1A, Reporting Investigation and Action on Serious Accidents/Incidents Involving NASA Employees, Resources, or Property, October 24, 1966.<sup>1</sup>

NMI 1712.1, Reporting and Analysis of Injuries Involving NASA Employees,  
October 2, 1964.<sup>1</sup>

NMI 5310.1, Reporting of NASA Parts and Materials Application Problems, February 15, 1964.<sup>1</sup>

<sup>1</sup> Available from the Center Administrative Distribution Point.

NMI 5310.2,	Participation of NASA Contractors in IDEP and FARADA, June 30, 1965.
NMI 5320.1,	Reliability Policy as Applied to NASA Programs, February 1, 1961. <sup>1</sup>
NMI 5330.1,	Quality Assurance Policy as Applied to NASA Programs, October 13, 1961. <sup>1</sup>
NMI 5330.2,	Quality Status Stamping Requirements, August 30, 1963. <sup>1</sup>
NMI 5330.4A,	Policies and Procedures for Recertification of Hand Soldering Personnel, October 4, 1966.
NMI 5330.5,	Policies and Procedures for Training and Certification of Personnel for Fabrication and Inspection Processes, June 29, 1965. <sup>1</sup>
NMI 6030.1,	Transportation for Large Vehicles and Spacecraft, December 23, 1963.
NMI 7100.1,	Conduct of Space Science Program - Selection and Support of Scientific Investigations and Investigators, April 29, 1964. <sup>1</sup>
NMI 7121.1,	Phased Project Planning (PPP), October 28, 1965. <sup>1</sup>
NMI 8020.1,	OMSF Authorization Document (M-A), August 2, 1965. <sup>1</sup>
NMI 8020.2,	OMSF Program Directive Documentation (M-D), August 2, 1965. <sup>1</sup>
NMI 8020.3A,	Manned Space Flight Flash Reports, November 10, 1965. <sup>1</sup>
NHB 2330.1,	Program Scheduling and Review Handbook, October 1965. <sup>1</sup>
NHB 5300.1A,	Apollo Reliability and Quality Assurance Program Plan, July 1966.
NHB 5300.2,	Apollo Metrology Requirements Manual, December 1965. <sup>1</sup>
NHB 5320.2,	Manual for Evaluating Apollo Contractor Reliability Plans and Performance, June 1965. <sup>1</sup>
NHB 5330.6,	Quality Audit Handbook, October 1965. <sup>1</sup>
NHB 5330.7,	Management of Government Quality Assurance Functions for Supplier Operations, April 1966.
NHB 5600.1,	Statement of Work Handbook, October 1966. <sup>1</sup>
NHB 7500.1,	Apollo Logistics Requirements Plan, November 1965. <sup>1</sup>

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<sup>1</sup>Available from the Center Administrative Distribution Point.

NPC 101,	NASA PERT and Companion Cost System Handbook, October 30, 1962. <sup>1</sup>
NPC 400,	NASA Procurement Regulations, January 1964. <sup>2</sup>
NPC 402,	Source Evaluation Board Manual, August 1964. <sup>1</sup>
NPC 500-1,	Apollo Configuration Manual, May 18, 1964. <sup>1</sup>
M-D E 8020.008,	Natural Environment and Physical Standards Specification, April 1, 1965. <sup>1</sup>
ML-SAAI-2314.1,	Data Management System Instruction.
MSC-A-D-66-3,	Procedures and Requirements for Evaluation of Apollo Crew Bay Materials.
MSC-A-D-66-4,	Crew Bay Non-metallic Materials Status Report.

#### CATEGORY C - INFORMATION

M-D E 8000.005,	Apollo Flight Mission Assignments, (latest edition). <sup>1</sup>
M-I MA 1450.045,	Delegation of Apollo Parts Information Activity Responsibility to MSC, February 2, 1965. <sup>1</sup>
M-I MP 9320.044,	Preparation and Revision of Program/Project Development Plans (PDP's), February 16, 1965. <sup>1</sup>
RA 006-007-1,	Apollo Reliability Estimation Guidelines, June 1966. <sup>1</sup>
SE 005-001-1,	Apollo Program Specification, April 1965. <sup>1</sup>
SP-6001,	Apollo Terminology, August 1963. <sup>3</sup>

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<sup>1</sup>Available from the Center Administrative Distribution Point.

<sup>2</sup>Available from the Center Administrative Distribution Point for all NASA activities and from the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402 for all Contractors.

<sup>3</sup>Available from the Scientific and Technical Information Division (Code US), National Aeronautics and Space Administration, Washington, D.C. 20546.

SP-6003,                      Quality Program Evaluation Procedures, September 1963.<sup>3</sup>

92-900-000,                NASA Projects Approval Document, Research and Development,  
Apollo, (latest edition).<sup>1</sup>

RA-006-013-1A,            Procedure for Failure Mode, Effect and Criticality Analysis  
(FMECA) August, 1966.

NHB 5300.3,                Handbook for Contamination Control on the Apollo Program,  
August 1966.

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<sup>1</sup> Available from the Center Administrative Distribution Point.

<sup>3</sup> Available from the Scientific and Technical Information Division (Code US),  
National Aeronautics and Space Administration, Washington, D.C. 20546.



## APPENDIX B

### REFERENCE INDEX

The following matrix correlates Reliability, Quality Assurance, and Test Interface requirements with applicable paragraphs of listed Program documents.

# REFERENCE INDEX FOR RELIABILITY

Document Requirement	AAP R&QA Plan	Program Development Plan	250-1	200-1A	200-2	200-3
1. Reliability Program Plan	2.2		2.2 App B, C&D			
2. Reliability Organization			2.1			
3. Reliability Program Requirements	2.2.2		2.6.2			
4. Reliability Program Control			2.4 5.2.3			
5. Reliability Audits and Reviews	2.4, 2.14		2.3			
6. Reliability Status and Progress Reports	2.15		5.2			
7. Reliability Documentation and Data	2.12, 2.13	Pg 13-7	5.1 5.3 App F			
8. Reliability Indoctination and Training		13.11	2.5			
9. Subcontractor and Supplier Control		13.5	2.6 3.62			
10. Reliability Evaluation Plan			4.2			
11. Reliability Evaluation Program Reviews			4.5			

# REFERENCE INDEX FOR RELIABILITY

Document Requirement	AAP R&QA Plan	Program Development Plan	250-1	200-1A	200-2	200-3
12. Mission Reliability Analysis	2.10					
13. Reliability Goals	2.4.5	13.14	3.2.1 4.5			
14. Reliability Assessment			4.4			
15. Reliability Prediction and Estimation			3.3			
16. Failure Reporting, Analysis and Corrective Action	2.6	13.7	3.7			
17. Design Specifications and Reviews	2.4		3.2 3.6			
18. Failure Mode, Effects and Criticality Analysis	2.8		3.4			
19. Standardization of Design Practices			3.8			
20. Drawing and Change Control			3.6.3			
21. Environmental Requirements	2.4.2		3.2.1			

# REFERENCE INDEX FOR RELIABILITY

Document Requirement	AAP R&QA Plan	Program Development Plan	250-1	200-1A	200-2	200-3
22. Mission Profiles	2.4.1 2.4.2		3.2.1			
23. Design Margins/Safety	2.4.4		3.2.1			
24. Single Failure Points	2.9					
25. Critical Parts			3.3 3.4			
26. Parts and Materials Program <ul style="list-style-type: none"> <li>o Organization</li> <li>o Parts Selection</li> <li>o Specifications</li> <li>o Qualification Tests</li> <li>o Approved Lists</li> <li>o Application Reviews</li> <li>o Data Bank</li> </ul>	2.12, 2.13,	13.12	3.9			
27. Limited Life Items	2.5.7					
28. Government Furnished Property		13.13	2.7			
29. Equipment Logs			3.10			
30. Maintainability and Elimination of Human-induced Failures	2.4.1		3.5			

REFERENCE INDEX FOR RELIABILITY

Document Requirement	AAP R&QA Plan	Program Development Plan	250-1	200-1A	200-2	200-3
31. In-Flight Maintenance	2.11					
32. Considerations for Experiments	2.3	13.16				
33. Flight Anomalies Reporting	2.7					

# REFERENCE INDEX FOR QUALITY ASSURANCE ELEMENTS

Document Requirement	AAP R&QA Plan	Program Development Plan	250-1	200-1A	200-2	200-3
1. Quality Program				3.1	2.1 5.3.1d 7.1	
2. Quality Plan	2.2			2.2	3.1	
3. Quality Organization				2.3	3.2	
4. Quality Audits and Reviews	2.4 2.14			3.10 Sect 4	Sect 15	
5. Quality Status and Progress Reports	2.15			2.5.2	14.2.1	
6. Quality Documentation and Data	2.12, 2.13	13.7		2.5	2.2 14.2 App B	
7. Quality Indoctrination and Training		13.11		2.4	13.1 13.2	
8. Motivation						
9. Subcontractor and Supplier Control		13.5		3.3 Sect 5	5.1 5.3	3.1
10. Evaluation and Selection of Procurement Sources					5.2 5.9	
11. Inspections and Inspection Systems		13.4.1		3.1 3.10 3.11	5.3.1c 5.5 7.4	2.1 2.3 3.6

# REFERENCE INDEX FOR QUALITY ASSURANCE ELEMENTS

Document Requirement	AAP R&QA Plan	Program Development Plan	250-1	200-1A	200-2	200-3
12. Inspection Plan					7.3	2.2
13. Receiving Inspection		13.4		3.8	5.6	
14. Government Inspection				Entire Document	5.3.1b 5.4 Sect 6	1.5 3.2
15. Indication of Inspection Status				3.2	5.7	3.10
16. Sampling Inspection and Statistical Q.C.					Sect 12	3.12
17. Records of Inspection and Tests				2.5	14.2	3.13
18. Fabrication Controls					7.5	
19. Inspection, Measuring and Test Equipment		13.4		3.5	Sect 9	
20. Inspection Stamps				3.2	Sect 10	
21. Personnel Certification		13.11		3.10	13.2	
22. Parts Identification and Traceability	2.12.2				4.4 5.3.1h 5.3.1i 5.3.1j 5.7	

# REFERENCE INDEX FOR QUALITY ASSURANCE ELEMENTS

Document Requirement	AAP R&QA Plan	Program Development Plan	250-1	200-1A	200-2	200-3
23. Identification, Handling and Storage of Material				4.2.3	Sect 11	3.4
24. Raw Material Control		13.5			5.3.1e 5.3.1f	3.5
25. Process Control				3.10	7.5	3.7
26. Preservation Packaging Packing and Shipment				3.12	5.3.1h Sect 11	3.11
27. Control of Inspection, Measuring and Test Equipment		13.10		3.5	Sect 9	3.9
28. Non-Conforming Articles	2.12.2	13.9 13.8		3.6 3.7	5.3.1j Sect 8	3.8
29. Government Furnished Property		13.13		3.9	Sect 6	3.3
30. Drawing and Change Control				4.2.2	2.3 5.3.1k	2.4
31. Failure Reporting, Analysis and Corrective Action	2.6	13.7		3.13	5.8 Sect 14	3.14

# REFERENCE INDEX FOR QUALITY ASSURANCE ELEMENTS

Document Requirement	AAP R&QA Plan	Program Development Plan	250-1	200-1A	200-2	200-3
32. Design Specifications and Reviews	2.4				4.2	
33. Parts and Materials Program	2.12, 2.13				4.2.2 4.3	
34. Limited Life Items	2.5.7			4.2.3	5.3.1i	

# REFERENCE INDEX FOR TEST INTERFACE ELEMENTS

Document Requirement	AAP R&QA Plan	Program Development Plan	250-1	200-1A	200-2	200-3	AATR
1. Test/R&QA Interface	2.5						2.2.7 3.2.1.4
2. Tests	2.5		4.1 4.2 4.3	3.1 3.11	5.10 7.4	2.1 2.3 3.6	Section 3 Section 4
3. Test Specifications			4.3.3a		7.2		5.3
4. Test Procedures			4.3.3b		7.3		5.4
5. Test Reports			4.3.3c	2.5	14.2		5.5
6. Qualification Tests		15.6.3	3.9.4		4.3		3.2.1.2
7. Environmental Acceptance Testing	2.5.2						3.2.1.5
8. Failure Reporting, Analysis and Corrective Action	2.5.5						5.5.4
9. Test Records			4.3.3c				5.6
10. Data Trend Monitoring	2.5.6						
11. Transient Malfunction Control	2.5.5(b)						

APPENDIX C  
GLOSSARY OF TERMS

The following definitions apply to terms used in, and in conjunction with, this publication:

APOLLO APPLICATIONS PECULIAR HARDWARE. Hardware used for Apollo Applications Program missions which is not of Apollo origin or part of the experiments.

ABORT. Premature termination of a mission because of existing or imminent degradation of mission success accompanied by the decision to make safe return of the crew the primary objective.

ACCEPTANCE. The act of an authorized representative of the Government by which the Government assents to ownership by it of existing and identified articles, or approves specific services rendered as partial or complete performance of the contract.

ALTERNATE MISSION. Deviation from the nominal mission plan, without premature termination, to pursue a substitute or modified set of primary and secondary mission objectives within the anticipated capability of the system.

ANOMALY. (FLIGHT). Any unexpected occurrence recognized in flight operations.

APOLLO BASIC HARDWARE. Hardware that has been designed and qualified for use in the Apollo Program.

APOLLO MODIFIED HARDWARE. Hardware that was originally designed for Apollo use but which is being modified to meet Apollo Applications Program performance/design requirements.

APPORTIONMENT. See Reliability Apportionment.

ASSEMBLY. A number of parts or subassemblies or any combination thereof joined together to perform a specific function.

ASSESSMENT. See Reliability Assessment.

CATEGORY 1 FLIGHT HARDWARE. Equipment whose failure could adversely affect crew safety.

CATEGORY 2 FLIGHT HARDWARE. Equipment whose failure could result in not achieving a primary mission objective but does not adversely affect crew safety.

CATEGORY 3a FLIGHT HARDWARE. Equipment whose failure could result in not achieving a secondary mission objective but which does not adversely affect crew safety or preclude the achievement of any primary mission objective.

CATEGORY 3b FLIGHT HARDWARE. Equipment whose failure could not result in loss of primary or secondary mission objectives nor adversely affect crew safety.

CATEGORY 1 FAILURE.\* The failure of any flight hardware which could adversely affect crew safety.

CATEGORY 2 FAILURE.\* The failure of any flight hardware which could result in not achieving a primary mission objective but does not adversely affect crew safety.

CATEGORY 3a FAILURE.\* The failure of any flight hardware which could result in not achieving a secondary mission objective but which does not adversely affect crew safety or preclude the achievement of any primary mission objective.

CATEGORY 3b FAILURE.\* The failure of any flight hardware which could not result in loss of primary or secondary mission objectives nor adversely affect crew safety.

CATEGORY A GROUND SUPPORT EQUIPMENT. Equipment whose failure could cause loss of a vehicle/module or adversely affect crew safety. (corresponds to KSC Priority I).

CATEGORY B GROUND SUPPORT EQUIPMENT. Equipment whose failure could result in not achieving primary mission objectives or cause a launch scrub. (corresponds to KSC Priority II).

CATEGORY C GROUND SUPPORT EQUIPMENT. Equipment whose failure could result in not achieving secondary mission objectives or cause a launch delay. (corresponds to KSC Priority III).

CATEGORY D GROUND SUPPORT EQUIPMENT. Equipment which does not fall into the above three categories. (corresponds to KSC Priority IV).

CATEGORY A FAILURE.\* The failure of any ground support equipment which could cause loss of a vehicle/module or adversely affect crew safety.

CATEGORY B FAILURE.\* The failure of any ground support equipment which could result in not achieving primary mission objectives or cause a launch scrub.

CATEGORY C FAILURE.\* The failure of any ground support equipment which could result in not achieving secondary mission objectives or cause a launch delay.

CATEGORY D FAILURE.\* The failure of any ground support equipment which does not fall into the above three categories.

\* Hardware failures can be either equipment induced or human induced failures.

COMPONENT. A part, assembly, or combination of parts, subassemblies, or assemblies, usually self-contained, which performs a discrete function in the operation of the overall equipment. A "black box."

CONFIGURATION. The technical and physical description required to fabricate, test, accept, operate, maintain, and logistically support systems or equipment.

CONTRACTOR. "Contractor" means any person, partnership, company or corporation (or any combination of these) which is a party to a contract with the United States.

CORRECTIVE ACTION. Action taken in order to eliminate or counteract failure deviation or anomaly or the source of same.

CREW BAY. Any portion of flight hardware which will be environmentally controlled for crew habitation.

CREW SYSTEM EQUIPMENT. Any equipment which is primarily designed for use by the crew or in support of the crew.

CRITICAL FAILURE. Any failure which is classified as Category 1 or 2 - See definition of Category 1 and 2 and Category A and B.

CRITICAL PART. A part, the failure of which is classified as critical.

DEFECT. Any nonconformance of a unit of product with specified requirements.

DESIGN SPECIFICATION. A document prescribing criteria to be satisfied in designing a particular component, subsystem, or system (or part). Typical criteria include performance requirements under specified environments, interface requirements, size, weight, ruggedness, safety margins, derating factors, and apportioned reliability goal (with definition of failure).

DEVELOPMENT TESTING. Conducted to determine if theories, techniques, and material are practicable, or if equipment and component items are technically sound, reliable, safe, and meet established specifications or requirements.

DEVIATION. Noticeable or marked departure from the accepted specification or requirement.

DISCREPANCY. See defect.

DISQUALIFICATION (PERMANENT). A specific hardware equipment end-item which is permanently disqualified cannot be used as flight hardware for any mission (current or future).

END ITEM. A space system or any of its principal system or subsystem elements, e.g., launch vehicle, spacecraft, ground support system, propulsion engine, or guidance system. Also, articles covered by major subcontracts where NPC200-2 is invoked by the NASA installation or by a system prime contractor. Also, articles which will be delivered direct to a Government installation or provided as GFP to a contractor.

EQUIPMENT. One or more assemblies, or combination of items, capable of performing a complete function.

EXPERIMENT. A test used in seeking the correct answer to a question relative to the field of space sciences, technology, and operations.

EXPERIMENT DEVELOPMENT PLAN. See Experiment Implementation Plan.

EXPERIMENT IMPLEMENTATION PLAN. A document provided by an experimenter to describe and plan the development of an experiment.

FAILURE. The inability of a system, subsystem, component, or part to perform its required function during test, operation or end use.

FAILURE ANALYSIS. The study of a specific failure, which has occurred, in order to determine the circumstances that caused the failure and to arrive at a course of corrective action that will prevent its recurrence.

FAILURE MODE, EFFECT AND CRITICALITY ANALYSIS .

- o FAILURE CRITICALITY ANALYSIS. Study of the potential failures that might occur in any part of a space system in relation to other parts of the system in order to determine the severity of effect of each failure in terms of a probable resultant safety hazard, unacceptable degradation of performance, or loss of mission of a space system.
- o FAILURE EFFECT ANALYSIS. The study of the potential failures that might occur in any part of a space system in order to determine the probable effect of each on all other parts of the system and on probable mission success.
- o FAILURE MODE ANALYSIS. The study of a space system and working inter-relationships of the parts thereof under various anticipated conditions of operation (normal and abnormal) in order to determine probable location and mechanism where failures will occur.

FAULT. See failure.

HARDWARE. The physical objects, as distinguished from their capability or function.

HUMAN-INDUCED FAILURES. Failures attributable to non-compliance of personnel to accepted and/or authorized procedure, either by omission or commission, such as improper maintenance, handling, storage, preservation, etc.; insufficient or improper direction; lack of safety precautions; negligence; ignorance; or sabotage.

IDENTIFICATION (For Traceability). A controlled serial, lot number, data code, or combined serial and lot number or date code which relates the article, assembly, model, or system to a particular lot of raw material, process, manufacturing data, cure date, receiving date, purchased lot, historical record, inspection or test data, calibration data, assembly process, matched articles, expiration date, operating time, X-ray, or other pertinent data.

INSPECTION. The examination of products and services to determine conformance to requirements.

INSPECTION AGENCY. A government agency, or any agency acting on behalf of the Government, to determine that products and services conform to requirements.

INTERFACE. The junction points or the points within or between systems or subsystems where matching or accommodation must be properly achieved in order to make their operation compatible with the successful operation of all other functional entities in the space vehicle and its ground support.

LAUNCH AVAILABILITY. The probability of the space vehicle meeting a specified launch window.

LIMITED LIFE ITEMS. All items that have a useful life dependent on a predetermined number of operating hours or cycles.

LOT NUMBER. A number which identifies raw material or a group of articles that are produced concurrently within the limits of a controlled process.

MAINTAINABILITY. The quality of the combined features of equipment design and installation that facilitates the accomplishment of inspection, test, checkout, servicing, repair, and overhaul with a minimum of time, skill, and resources in the planned maintenance environments.

MALFUNCTION. See failure.

MILESTONE. Any designated event in the design and development of a space system or in the associated reliability program which is used as a control point for measurement of progress and effectiveness or for planning or redirecting future effort. Reliability program milestones should be identified in the Reliability Program Plan.

MISSION CONTROL. That portion of flight operations concerned with the operation of the primary mission control centers.

MISSION ESSENTIAL GROUND SUPPORT EQUIPMENT. Any ground support equipment which is functionally essential to the successful completion of the launch.

MISSION PROFILE. A graphic or tabular presentation of the flight plan of a spacecraft showing all pertinent events scheduled to occur.

MISSION SUCCESS. The attainment of all major objectives of the mission as defined in the mission and flight directive with no crew fatality.

MODEL. An analytic or physical analogue or representation of the system having the property that operations with the model duplicate those with the system in the characteristics of interest.

NON-CONFORMANCE. See defect.

OPEN FAILURE. Any reported failure which has not been resolved by defined corrective action or, if it has been defined, adequate implementation has not as yet taken place.

PART. One piece, or two or more pieces joined together, which are not normally subject to disassembly without destruction.

PAYLOAD INTEGRATION CENTER. The center responsible for the integration of the experiment carrier and payloads (i.e., experiments, experiment unique support equipment and expendables) into a coordinated experiment module qualified for flight.

PREDICTION. See Reliability Prediction.

PRIME CONTRACTOR. A contractor with total system responsibility for the execution of work in contract to a government agency. This includes all functional and administrative responsibilities necessary to satisfy contract requirements.

QUALIFICATION. Determination by a series of tests and/or examinations of documents and processes that a part, component, subsystem, or system is capable of meeting performance requirements prescribed in the purchase specification or other documents specifying what constitutes adequate performance capability for the item in question.

QUALITY ASSURANCE. A planned and systematic pattern of all actions necessary to provide adequate confidence that the end items will perform satisfactorily in actual operations.

QUALITY CONTROL. A management function to control the quality of articles to conform to quality standards.

REDUNDANCY (of Design). The use of more than one means of accomplishing a given task or function where all must fail before there is an overall failure of the system.

RELIABILITY. The probability that a system, subsystem, component, or part will perform its required functions under defined conditions at a designated time and for a specified operating period.

RELIABILITY APPORTIONMENT. The assignment (by derivation from the contractual reliability requirement) of reliability goals to systems, subsystems, and components within a space system which will result in meeting the overall contractual reliability requirement for the space system if each of these goals is attained.

RELIABILITY NUMERICAL ASSESSMENT. An analytical determination of numerical reliability of a system or portion thereof. Such assessments usually employ mathematical modeling, use of directly applicable results of tests on system hardware, and some use of estimated reliability figures.

RELIABILITY DEMONSTRATION. Statistically designed testing, with specified confidence level, to demonstrate that an item meets the established reliability requirement.

RELIABILITY ESTIMATION. An analytical determination of the reliability of a system or portion thereof utilizing mathematical modeling techniques and data applicable to the apportionment, prediction, or assessment process.

RELIABILITY PREDICTION. An analytical estimation of numerical reliability of a system or portion thereof similar to a reliability assessment, except that the prediction is normally made in the earlier design stages where very little directly applicable test data is available.

REPETITIVE TESTING. A series of similar tests performed on like hardware.

REQUALIFICATION. Repetition of qualification testing of an item using new test specimens to determine whether the item still meets qualification requirements. Usually conducted after a design or material change in the item or when there is reason to doubt that it is still representative of the item originally qualified.

## SAFETY.

- o CREW SAFETY. The safe return of all crew members whether or not the mission completed.
- o RANGE SAFETY. The process of minimizing hazards to persons or property attendant to space vehicle operations and associated activities.

- o GROUND SAFETY. That portion of Range Safety concerned with hazards associated with receipt, inspection, maintenance, assembly and preparation of space vehicles prior to launch countdown excepting those reserved to Flight Safety.
- o FLIGHT SAFETY. That portion of Range Safety concerned with hazards attributable to space vehicle launch (including countdown), flight and impact. It includes safety systems and conditions pertinent to safe launch and flight, e.g., launch danger area, flight termination systems, and hold fire capability.
- o INDUSTRIAL SAFETY. Encompasses manufacture, test and acceptance operations, maintainability and servicing aspects of space vehicle systems, launch facilities and associated equipments, and personnel safety prior to vehicle countdown for launch.

SERIAL NUMBER. A number which identifies individual articles, assemblies, and equipment.

SINGLE FAILURE POINT. A single item of hardware which, if it failed, would lead directly to loss of a part, component, system, mission or crew member. (see Category 1, Category 2, Category 3a).

SPACE VEHICLE. A launch vehicle and its associated spacecraft.

SOFTWARE. Activities such as studies, analyses, reviews, services and documentation relating to both the physical objects (hardware) and their capabilities and functions.

SYSTEM INTEGRATION. The management process by which the systems of a project (for example, the launch vehicle, the spacecraft, and its supporting ground equipment and operational procedures) are made compatible, in order to achieve the purpose of the project or the given flight mission.

TRACEABILITY. The ability to trace the history, application, use, and location of an individual article or characteristic lot of articles, through use of the recorded identification numbers.

TRANSIENT MALFUNCTION. A temporary excursion from drawing and specification requirement for which no explanation or conclusive repair can be found.

UNSATISFACTORY CONDITION. Any non-conformance to requirements, procedures or accepted standards, including defects and failures.

VERIFICATION. The process whereby any system element (e.g., flight hardware, ground support equipment, ground operational support systems) demonstrates its capability to perform specified mission requirements. The process may include flight tests, ground tests, special studies, and qualification testing.

WAIVER. Granted use or acceptance of an article which does not meet specified requirements, but which is considered to meet the operating requirements of the particular use.